Building An All Sky Camera

By Gord Tulloch, RASC Winnipeg Centre

Part of my Master Plan™ for my observatory is a weather station including an allsky camera that can show me whether there's any cloud and, hopefully, actually be able to tell the observatory that a target is unobscured and able to be observed i.e. "automated sucker hole observing". So when Ontario Telescope accidentally sent me a second ZWO ASI224MC planetary imaging camera (review coming up Real Soon Now) I took the opportunity to negotiate a really good "lets save the shipping" price from them so I could use the camera for an all sky camera. The fact that the ASI224MC is the most popular camera for allsky cameras on the facebook Allsky Camera group and is well supported by the software I wanted to use made this camera a clear choice.

So what is an Allsky Camera? Basically, a camera that points straight up and with a wide enough field of view to encompass the entire sky. Obviously, this means the the camera needs to be enclosed in a way it will survive the weather 24/7/365. The result is an image like this one:

Figure 1 – Sample Allsky Image from the SPAO Allsky Camera

In my case my camera would be situated close to my observatory so it would need to be elevated to get as wide a field view of the sky as possible and as little houses and trees as possible. So a stout pole or pier was required.

After I found a design I liked on the Facebook group I ordered a weatherproof enclosure and 6" transparent dome (figure 2.) The domes are typically used in underwater photography and are relatively inexpensive. My first attempt to order a dome was from a supplier in China and it is apparently still in transit – I eventually gave up and ordered a second dome from the US supplier that was a couple of dollars more but arrived within a week. Lesson learned!

Figure 2 – Weatherproof box and dome

Although the ASI224MC comes with a 2.1mm lens but it would not afford a 180° view so I also ordered a 1.55mm F1.5 fisheye lens from Amazon which would provide horizon to horizon coverage.

Figure 3 – 1.55mm F1.5 fisheye lens

For computing power I chose to embed a Raspberry Pi 3B+ I had lying around – this is still a current model of the Raspberry Pi despite the Raspberry Pi 4 being out. The 3B+ has plenty of computing power to run the camera and a lot more, and has the benefit of being much cooler to run than the Rpi4, which runs much hotter due to it's much faster processing power. With the computer actually being embedded with the camera, it's a bit of a problem getting power to the box up a pole – I wanted to avoid clumsy AC adapters and 120v power going up the pole but since I intended to plug the camera into my ethernet network in the observatory, the solution was simple: Power Over Ethernet (POE.) This standard is commonly used to run remote cameras, wireless access points and so on. And, a POE "hat" was available for the RPi so I could just plug it into the computer and power it through the same ethernet cable that connected it to the network. All that's needed is a POE injector, where you plug the device cable into the injector, and a cable to the network, and the injector provides power through unused conductors in the network cable. At the Raspberry Pi, the power is converted from 48v POE power to the 5v the RPi needs. And now I have plenty of power for not only the Pi and the camera, but the rest of the future weatherstation gear I'll mount on the pole. QED!

Once all the bits and pieces arrived I was able to print a camera mount on my son's 3D printer and get everything mounted in the case (figure 4.) The red line around the dome is a piece of elastic that gets compressed by the screws securing the dome to the case, creating a nice watertight seal. Being a belt and suspenders kind of guy, I also sealed the dome with clear silicon sealant that's easy to cut if I need to get into the dome later but absolutely not going to let any moisture into the enclosure. Of particular concern is condensation on the dome if moisture gets into the enclosure – so far so good. Next time I open the case I'll probably add a bad of dessicant to ensure that any moisture that somehow makes it way into the case is absorbed. The heat from the Rpi and POE hat will likely be enough to keep everything warm enough to operate during the winter but time will tell. So far the entire setup runs at about 46°C during a 25°C day so it's probably unlikely it will exceed the RPi's 85°C operating ceiling (which would trigger a thermal shutdown to protect the computer.)
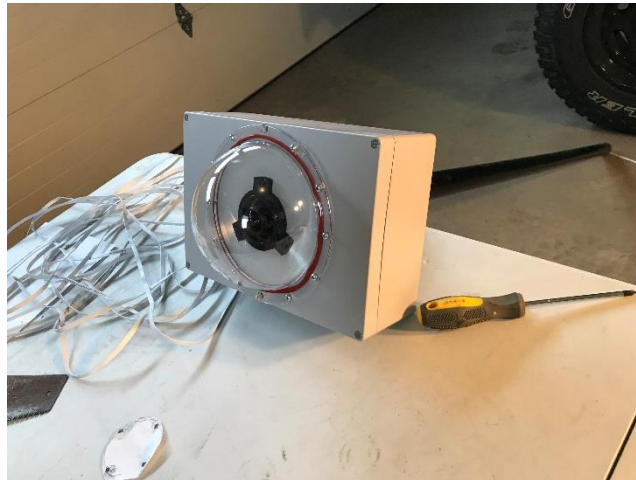

Figure 4 – Completed camera

My initial attempt at putting the camera on a pole mounted on a piece of PVC pipe was a real indicator that I hadn't thought the mounting through real well – the camera box whipped around on the pretty flexible pole and would probably end up with the camera box being catapulted into the farmer's field behind my house in any sort of wind, so a redesign was indicate. As usual, when in doubt, over-engineer the sh** out of the problem so my final solution was 4 2x4s screwed together in an overlapping pattern so I could route the ethernet cable from the camera down to ground level, and trench it under the sod over to the observatory so it wouldn't need to be routed anywhere where it could be cut or otherwise molested.

Figure 5 – Camera mount

With the Raspberry Pi mounted on the pole, the only remaining task was to get the software working. The software I chose (which enabled use of the Raspberry Pi) was written by Thomas Jacquin, an amateur astronomer from Yukon NWT. Since the software is open source (located at https://github.com/thomasjacquin/allsky,) not only was it free but I can modify it later to incorporate my weather station hardware. And even better he's developed a web site addon that will display the camera images in almost real-time as well as host time-lapse videos, keeograms (a single image summary of the night's occurrances,) and star trail images. What an amazing contribution!

I won't repeat the install instructions for the software since instructions on github are very comprehensive. If you're interested in seeing the resulting web site please feel free to check out http://www.gordtulloch.com/allsky. I'm really looking forward to seeing some aurora images from the camera, and taking it to Spruce Woods Star Party – I ordered a second box so I can just transfer the camera assembly to a new box to take to dark sky sites.

Clear Skies!